Purge Systems for LDCM and Contamination Instruments Project

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Agenda

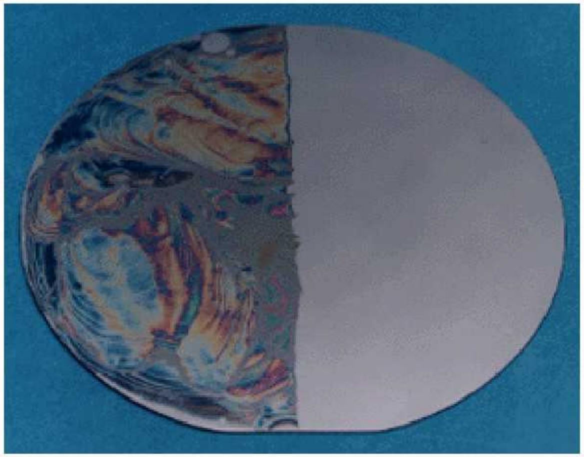
- Contamination Overview
- Introduction to tools and techniques
- Overview on Landsat 8 (LDCM)
- Tools
- Techniques
- Works Cited
- Special Thanks
- Questions

Contamination Overview

There are two types of contamination

Particulate: emitted by personnel, equipment, hardware, dust, skin cells, fibers, debris

Figure 1:
Particulate contamination on Radiators



Molecular: non-particulate substances that include oil, chemicals, vapors, hydrocarbons, films, greases, skin oils, ice.

Figure 2: Molecular Contamination on a Si Wafer

What are we looking at?

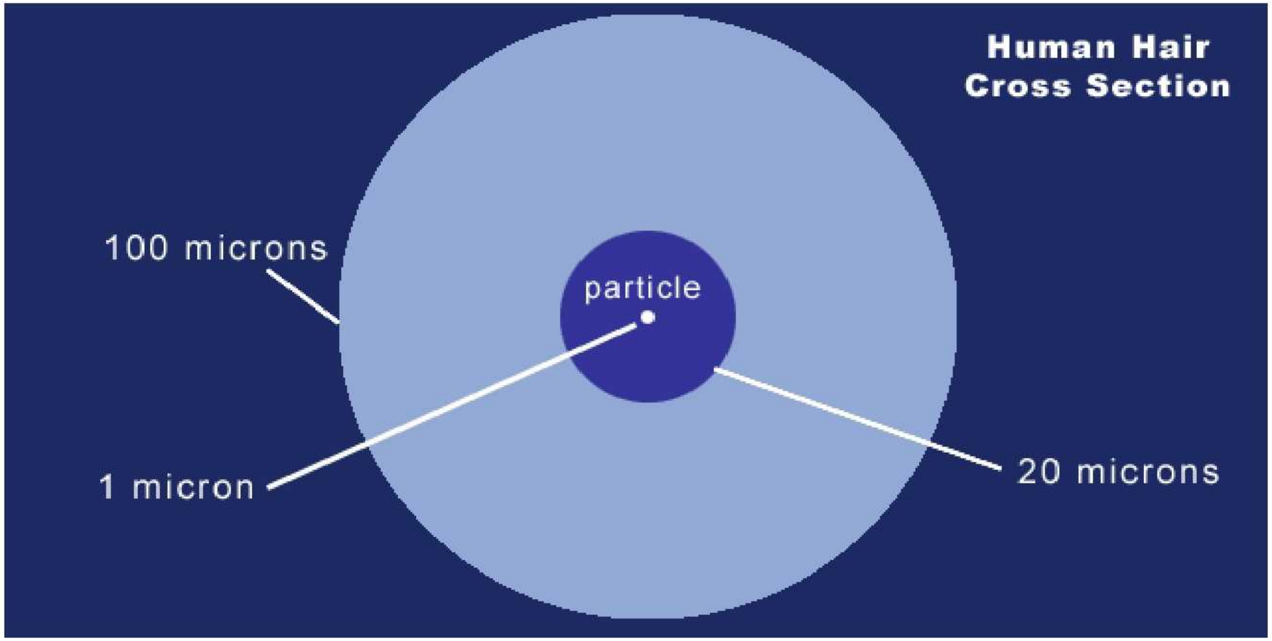


Figure 3: Cross section reference

- When speaking of particulate contamination we are talking about particles that are very small and not necessarily visible to the eye.
- The Majority of my research was focused on particulate contamination
- The graphic above demonstrates the variance in particulate size.
- The smallest visible particles are approximately 50 microns.

Introduction to Tools and Techniques

In order to achieve mission success, contamination control engineers at NASA try to determine the extent of contamination by performing surface inspections and cleanliness level verifications with tools and techniques such as those presented in this summer research project:

- Dino-Lite hand held microscope
- Cleanroom Contamination Field Kits
- ECG Borescope
- Purge Suitcase for Landsat 8
- NVR rinses
- Swabs
- Tape lifts
- Visual inspection techniques

LDCM Overview

- Landsat offers a rich archive of global mid-resolution, highly calibrated, multispectral data of Earth's landmasses.
- To extend this legacy, plans are in the works for a December 2012 launch of the **Landsat Data Continuity Mission (LDCM)**, which will collect and archive data consistent with its 7 predecessor Landsat satellites.
- NASA selected Ball Aerospace and Technology Corporation to build LDCM's Operational Land Imager (OLI) instrument.
  - OLI carries an optical instrument that is sensitive to Hydrocarbons and particulates
- Thermal Infrared Sensor (TIRS) is a two-channel thermal imager, providing 100-meter (328 feet) spatial resolution across a 185 km (115 mile) field-of-view. Both Landsats-5 and -7 provide thermal data, and the addition of TIRS will extend the Landsat database in the thermal infrared bands needed by a variety of users.
  - The TIRS instrument is sensitive to water.

The Purge Suitcase

- The purge systems help reduce contamination levels and to keep the instrument clean and dry.
- The purge suitcase is used as a contamination mitigation tool.
- The purge system allows nitrogen gas to flow through tubing lines connected to the instrument.

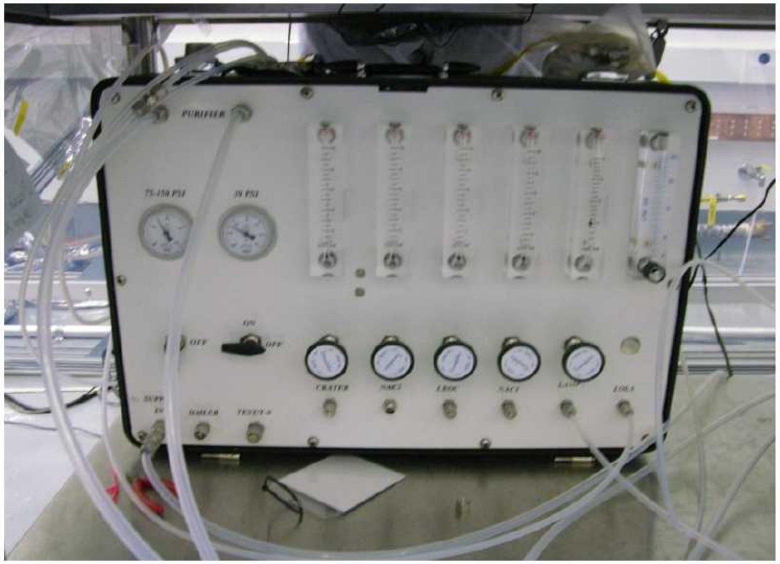


Figure 4: Purge Suitcase

Why is it useful?

- It is portable
- It can be used and transferred anywhere alongside LDCM by being placed atop a cart
- It serves as a redundant relief valve
- Provides varying flow control, additional particle filtration, and gas purification

Purge Requirements

Purge Requirements for TIRS

Gas Quality:	Grade B with additional filtration
Filtration:	Needs to reduce water, Hydrocarbon, and particulate levels to a Grade C Equivalent
Flow Rate:	Covers on: 1 scfh Covers Off: 5 scfh

Purge Requirements for OLI

Filtration:	Needs to reduce total hydrocarbons to <200 ppb and water at 25 ppm, and particulates at 5 micron or less
Flow Rate:	12 L/min with shower caps installed 40 L/min with shower caps removed 5.25 L/min with shower caps removed and while inside a closed fairing

- In order to meet these requirements, I met with Gene the purge suitcase technician to relay specifications.
- We had three meetings in all. He showed me the basic components and schematics of the purge suitcase
- The idea is to retro fit the purge suitcase that was previously used on LRO.

CLEANROOM CONTAMINATION (CC) SUITCASES

About the CC kits:

The CC kits greatly reduce the annoyance of having to look for small items within the Cleanrooms in order to perform sampling, cleaning, inspections, etc. Everything is in one suitcase with a handy check list for anyone that decides to check one out.

Figure 5: CC Suitcase (credit to Drew and Rachel)

- For cleanliness verification:
  blank tape lifts, Scanning Electron Microscope (SEM) kit, Non-Volatile Residue swabs, wipes, rinses, and silicone wafers for fallout.
- For visual cleanliness inspection:
  handheld microscope, LED flashlight, and UV flashlight.
- The other items are used in conjunction with these tools

ECG BORESCOPE

About the Borescope:

- The borescope is used as an inspection tool.
- It has a flexible camera extension enabling it to look at hard to reach areas
- It is capable of taking real-time video and pictures.

Accomplishments:

•Wrote procedures on how to use it
•Demonstrated its capabilities with real time demos for people that were interested
•Determined that the resolution is at about 1mm.

Figure 6: ECG Borescope

DINO-LITE DIGITAL MICROSCOPE

About the Microscope:

- The portable Dino-Lite handheld microscope was used as a convenient means for in situ inspection and verification of particulate contamination.
- The size of particles and shape can be determined real-time through the imaging software provided.

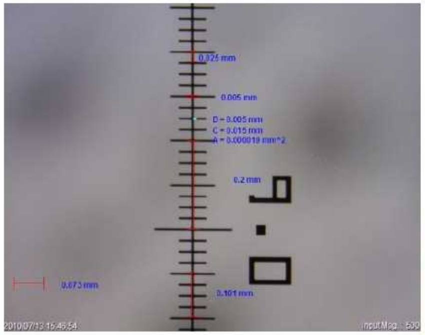


Figure 7 : stage micrometer

Figure 8: 500x microscope

Accomplishments

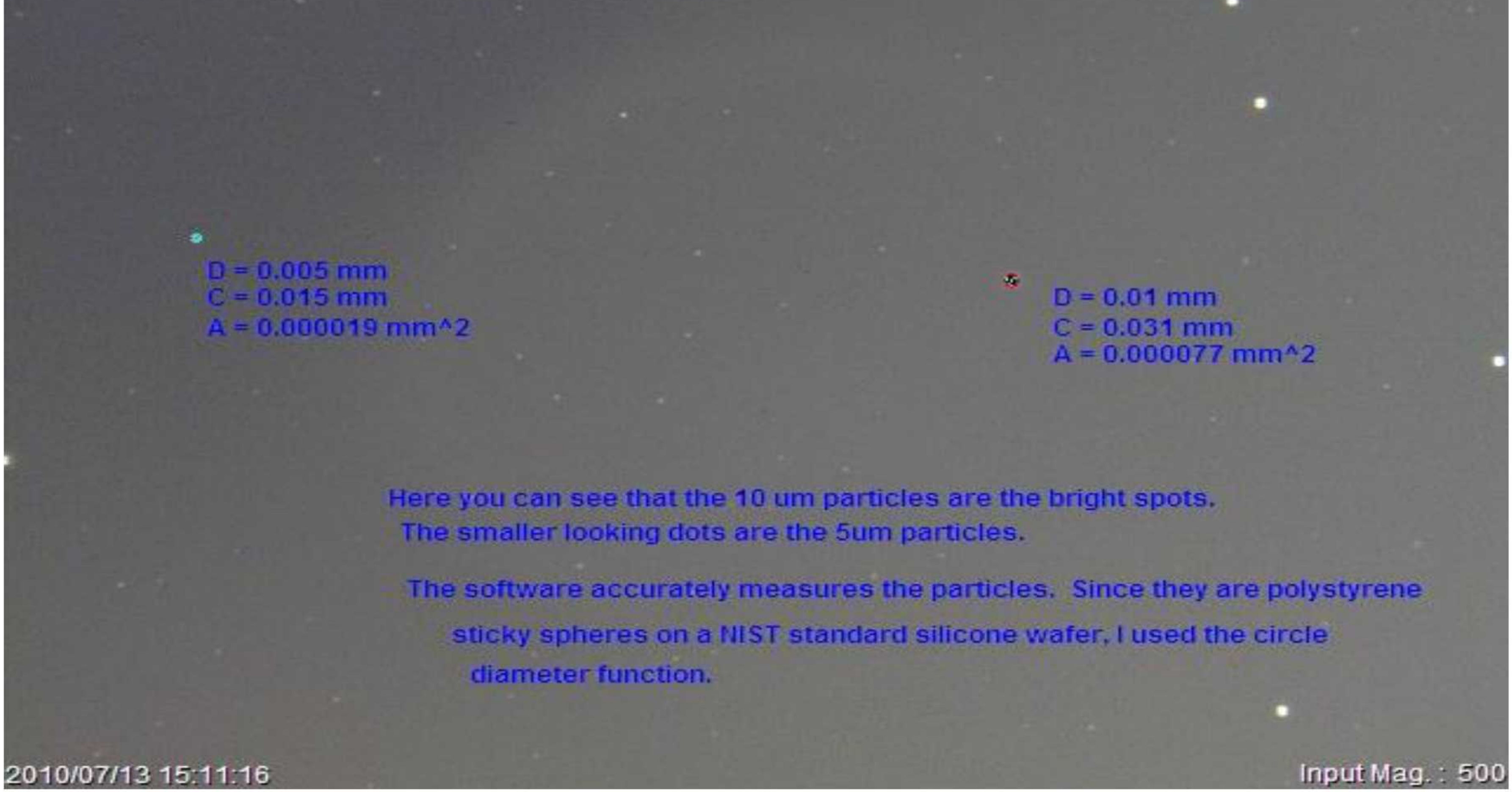
- I tested and verified the capabilities by using the software to calculate the particle sizes using a NIST calibrated wafer with known particle size distribution and by using a stage micrometer.
- I wrote procedures on how to initially use the microscopes, and eventually, how to analyze the pictures with the software such as PAC.

$$PAC = \frac{total - area - of - particles}{total - Area} \times 100$$

Figure 9: Strand of Hair

Software and Microscope Validation

Note: The NIST calibrated wafer came complete with a histogram of the distribution of spheres.



CONTAMINATION VERIFICATION METHODS AND TECHNIQUES

- I was provided with on the job training on using inspection techniques and how to apply them with real situations. (credit: Karrie Houston)

PARTICULATE VERIFICATION METHOD

Extractive Sampling:

Tapelift: Traditional method- Count adhered particles with microscope

Figure10: Tapelift

MOLECULAR VERIFICATION METHODS

Non-Volatile Residues (NVR):

•Rinse hardware surface off or swab sample with IPA/Acetone and collect rinse

•Allow rinsate to dry; weigh remaining NVR

•Run solvent through FTIR Analysis/also GC-Mass Spec to determine species and quantity

Figure 11: NVR rinse

Figure 12: Swab sample

VISUAL INSPECTION METHODS

White Light
Visible bright light inspection

Figure 13: White light

Black Light/Green Light
Particles fluoresce and absorb UV radiation

Figure 14: UV/black light

Works Cited

- http://ldcm.nasa.gov/
- http://bigc.com/products_handheld_dinoAM413T5.php

Special Thanks

- Thurgood Marshall College Fund,Rachel Rivera, Randy Hedgeland, Joseph (The Hammer) Hammerbacher, Sharon Straka, Gene Mcalicher, Robert Gorman, Karrie Houston, Marcello Rodriguez, The Aeronex lab team- Anthony Mucciacciaro, Victoria Duncan, Azuka Harbor- Bobby Price, Mark Hasegawa, Edmonia Caldwell, The Pre- Clean Team, Lauren Mosier, Katherine Handler, Claudia Jardine, Ms. Terri Patterson, Ms. Janie Nall, Dr. Joan Langdon, Mr. Gerald (Tiki) Tiqui, Jay O'leary, Justin Price, NASA and their great employees. To anyone that helped me through out my internship here, and I forgot to mention,

Thank You

Questions?

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